How to do Effective TMDLs on Rivers: Blending Technical and Social Studies to Improve Water Quality

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“Doing TMDLs”

- Three Phases of CWA 303d Process:
  - Listing Impaired Waters = **f (WQS, Monitoring)**
  - Developing TMDLs = Technical Analysis of Pollutant Loading
  - Implementing TMDLs = Social Participation and Investment in Treatment and BMPs

Anatomy of a TMDL

1. WQC Violated Sufficiently to Impair Designated Uses
2. Define Endpoint to be Attained = WQC
3. Define Characteristics of Impairment =

   f (Season, Hydrology, Magnitude, Frequency, Duration)
4. Define Responsibility of Loaders by Allocation: WLA, LA, MOS

Anatomy of a Good TMDL

Previous Four Components, and:

5. Implementation Plan for Point and Non-Point Sources
6. Monitoring Plan and Timeline for Evaluation
7. Public Participation, Feedback and Revision

Stream TMDL Considerations

1. Spatially and Temporally Dynamic

   KS: typically 80% of samples show no problem

2. Multiple Points of Loading within Watershed – Also Varied with Time
3. Linear Community of Interest
4. Shared Boundary Issues

The Mass Balance of TMDLs

TMDL = WLA + LA + MOS

(q * C) + (Q * C') = [(Q + q) * WQC] * discount

?	?	?	?
WLA	LA	TMDL	MOS

Hydrology Matters: Which Q?

Q = 7Q10 for point sources

Q = Q_{avg} ; Q_{med} for non-point sources

Q = Q_2 ; $Q_{25,24}$ for major runoff

Major TMDL Principle for Streams

Concentration is more important than Load; the endpoint will be the water quality criterion expressed as a concentration; loading is merely the mechanism of transport and a commodity for allocation. (Load is important for stored water impairments – lakes, aquifers)

Therefore, a stream TMDL cannot be a single load value, it must be a continuum of loads across the hydrologic spectrum

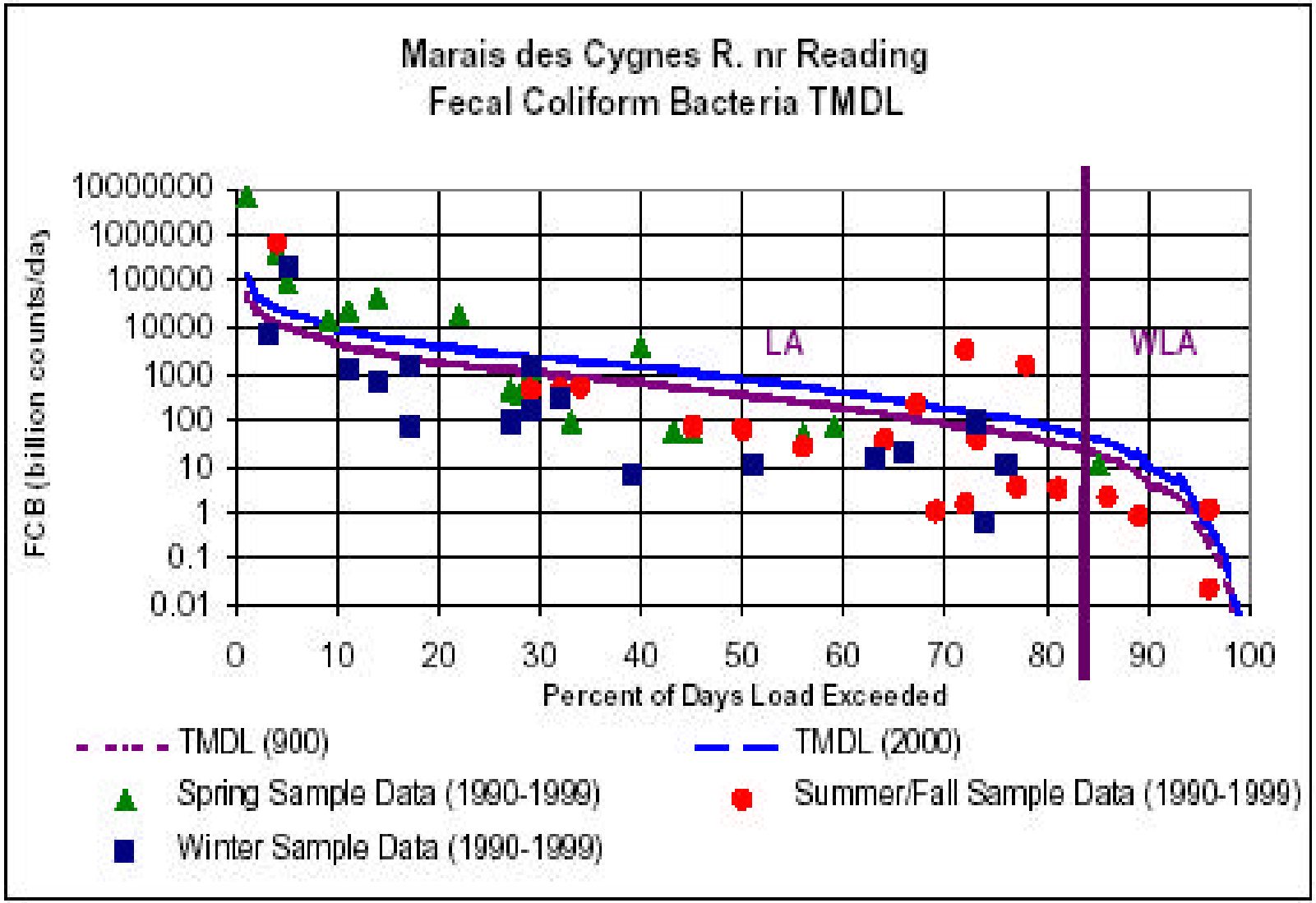
A Good TMDL Defines the Impairment

303d List: Water Impaired because WQS unmet --- examines what & where

TMDL examines who, when, why & how within the context of the stream's hydrology

Generally, Point Sources responsible for low flow impairments; NPS responsible for high flow impairments

(Exceptions: Stormwater, spills, cattle in stream)


Marais des Cygnes R. nr Reading
Fecal Coliform Bacteria TMDL
FCB (billion counts/day)
10000000
1000000
100000
10000
1000
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
90
100
Percent of Days Load Exceeded
LA
WLA
TMDL (900)
TMDL (2000)
Spring Sample Data (1990-1999)
Summer/Fall Sample Data (1990-1999)
Winter Sample Data (1990-1999)

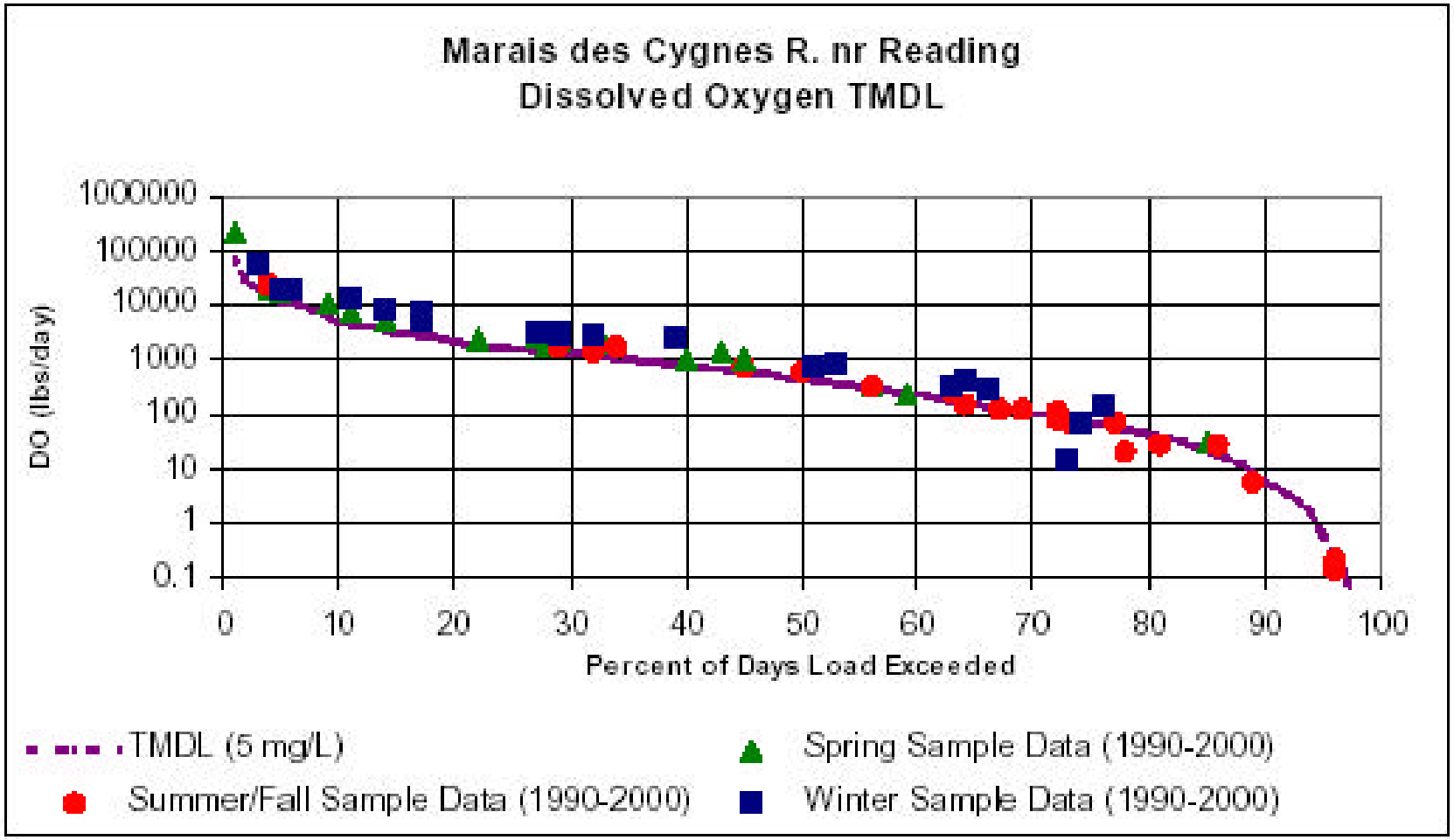
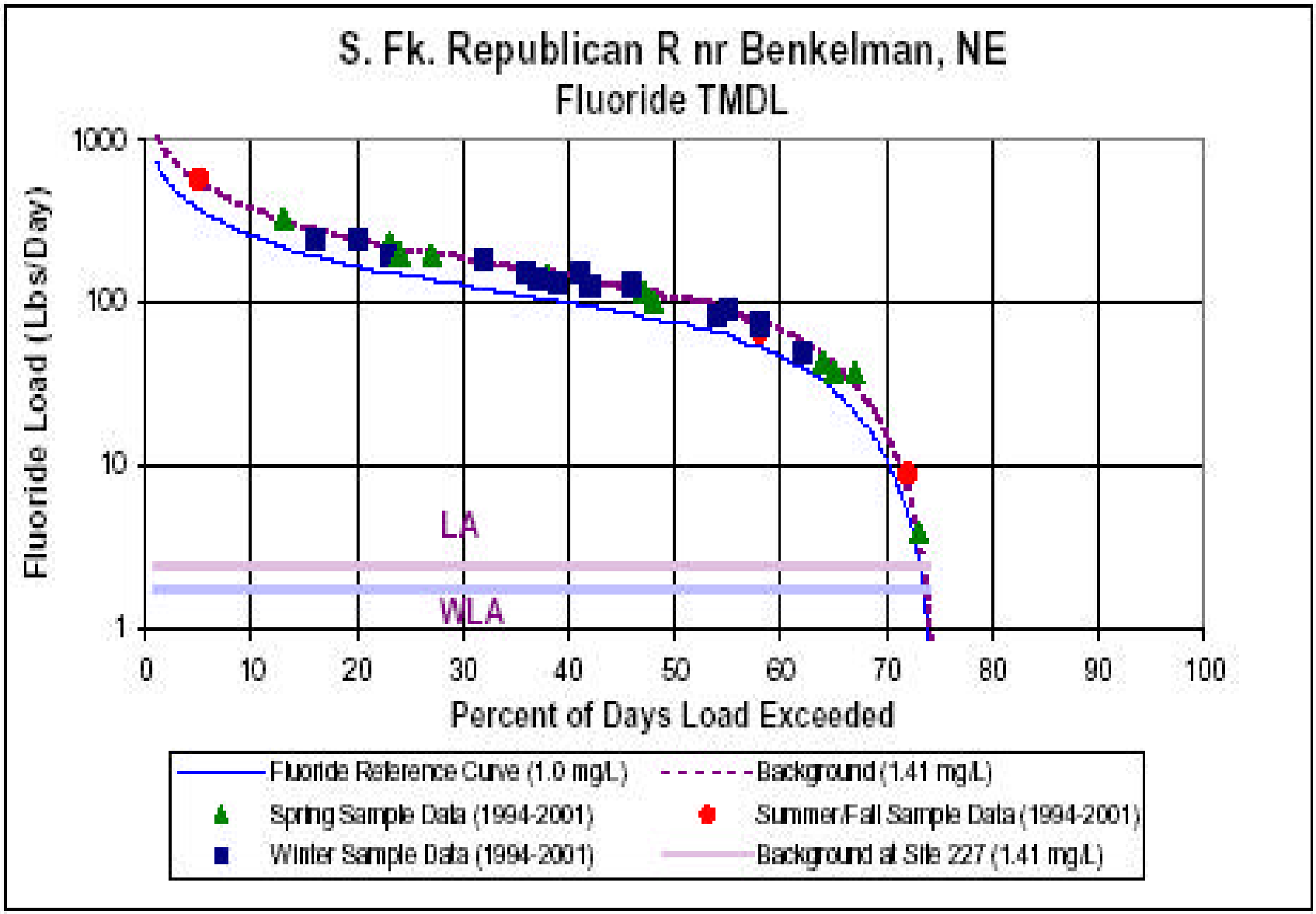

Marais des Cygnes R. nr Reading
Dissolved Oxygen TMDL
DO (lbs/day)
1000000
100000
10000
1000
100
10
1
0.1
0
10
20
30
40
50
60
70
80
90
100
Percent of Days Load Exceeded
TMDL (5 mg/L)
Spring Sample Data (1990-2000)
Summer/Fall Sample Data (1990-2000)
Winter Sample Data (1990-2000)

Figure 3


S. Fk. Republican R nr Benkelman, NE
Fluoride TMDL
Fluoride Load (Lbs/Day)
1000
100
10
1
LA
WLA
0
10
20
30
40
50
60
70
80
90
100
Percent of Days Load Exceeded
Fluoride Reference Curve (1.0 mg/L)
Background (1.41 mg/L)
Spring Sample Data (1994-2001)
Summer/Fall Sample Data (1994-2001)
Winter Sample Data (1994-2001)
Background at Site 227 (1.41 mg/L)

A Few Notes on Stream Biology

1. Biology integrates the impacts from the watershed over time, it is the best metric for judging the health of a stream.
2. Ties water quality directly to the Aquatic Life Use that is ubiquitous for every stream.
3. Stresses to Biology come on multiple fronts; pollutants, habitat disruption, flow alterations and extremes, nuisance species.
4. Only pollutants lead to TMDLs

Implementation

Classically, wasteload allocations are implemented through NPDES permits; load allocations are implemented voluntarily through cost-share programs for BMPs.

Stream TMDLs do not add up, thus use the stream hydrology to assign responsibility for action among sources.

TMDL Implementation Needs

A TMDL should bridge the development and implementation phases by:

1. Providing sufficient time to install corrections and practices (5-15 years)

2. Directing targeted $$ for implementation (319, EQIP, State & Local Funds)

3. Identifying and tasking the people responsible for implementation.

A TMDL's True Audience

A TMDL should be directed to State and Local Water Quality Program Managers; not individuals. TMDLs direct program resources and priorities, not individual action.

Federal & State Environmental & Conservation Agencies

Conservancy & Watershed Districts and Councils

Local Environmental and Health Agencies

TMDL Targets

1. Geographic Areas – Watersheds within State; Sub-Watersheds within Watersheds
2. Activities – Urban, Agricultural, Silviculture, Construction, Mining
3. Programs – NPDES, 319, Farm Bill, Stormwater Management Programs
4. Delivery Agents – Permit Writers, WQS Developers, Watershed Managers, Extension Agents, Conservationists, Environmental Educators, Local Government

TMDL Outreach

1. Financial Assistance – Cost Share, Revolving Loan Funds

2. Technical Assistance – BMP Selection, Installation and Maintenance

3. Educational Assistance – Awareness of Watershed Community & Stream Connectivity

Hierarchy of TMDL Process

1. Monitoring begets Listing
2. Listing begets TMDL Development
3. TMDL Development begets Implementation

TECHNICAL PHASE ? SOCIAL PHASE

4. Implementation directs Agencies
5. Agencies target Programs
6. Programs invite Participants
7. Participants invest Practices

SOCIAL PHASE ? TECHNICAL PHASE

8. Monitoring evaluates Implementation and Listing

Technical Constraints and Caveats

1. Watersheds feed streams, therefore, if the problem is nps, we have to treat a lot of real estate.
2. Field plots have shown the effectiveness of BMPs, but few know the density threshhold for installing BMPs over a watershed to impact water quality.
3. The nature of nps means different areas will contribute pollutants at different times.
4. Extremes in hydrology and hydraulics will defeat BMPs every time
5. Increases in watershed and hydrologic scales constrain implementation through increases in costs and participants.

Social Constraints and Caveats

1. While typically, no one individual is responsible for the impairment, all individuals have to be aware of their position within the watershed.
2. There are never enough monitoring data to pinpoint targets within a watershed.
3. Extensive monitoring invites paranoia.
4. Financial resources at all levels are limited and often non-recoverable.
5. The biggest challenge is motivating individuals to act to benefit areas beyond their lands.

Motivation

1. Water Quality Standards
    a. Criteria – Chronic, Acute, Background
    b. Designated Uses – Recreation, Aquatic Life & Water Supply
    c. Anti-Degradation
2. Environmental Stewardship
3. Economic Sustainability
4. Litigation

Ten Suggestions

1. Examine impairments in the context of hydrology
2. Translate technical information into socially understood English
3. Minimize the exposure of the individual; each level of government should be a shield from the level above it.
4. TMDL Development is Strategic Planning; TMDL Implementation is Adaptive Management
5. Mandates are unmanageable, but Status Quo is unacceptable
6. In lieu of saturating the watershed with BMPs, adhere to the power of proximity; insulate the stream from surrounding land use.
7. Monitoring the watershed at its outlet is a State matter; monitoring within the watershed is a Local matter.
8. Peer pressure is more effective than State/Fed edict
9. Each interest group views TMDL in the context of its culture; in the early stages, keep the groups separate to have their say.
10. Investments of time and money have to be made at all levels.

Judging the Effectiveness of TMDLS

1. In the near term, effectiveness is judged by social participation in water quality programs.
2. Over the course of a decade, effectiveness is judged technically by improvements in water quality.
3. Over the long term, effectiveness is judged by attaining WQ Standards and delisting the water.

Conclusion

Developing and Implementing a Stream TMDL is not Rocket Science; it is MUCH harder!